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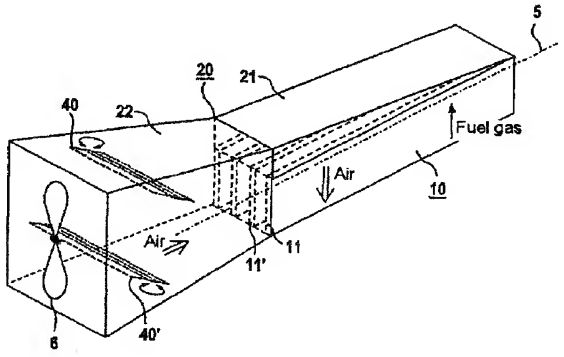
(71)
SIEMENS AKTIENGESELLSCHAFT,
Wittelsbacherplatz 2
D-80333, MÜNCHEN, XX (DE).
EMITEC GESELLSCHAFT FUR EMISSIONSTECHNOLOGIE MBH,
Hauptstrasse 150
5204 Lohmar 1, XX (DE).

(72)
BRUCK, ROLF (DE).
REIZIG, MEIKE (DE).
GROSSE, JOACHIM (DE).
POPPINGER, MANFRED (DE).

(74)
FETHERSTONHAUGH & CO.

(54) SYSTEME DE PILES A COMBUSTIBLE POUR AUTOMOBILE
(54) MOTOR VEHICLE HAVING A FUEL CELL SYSTEM

(57)
An inventive fuel cell system has at least one fuel cell module that is mounted on the vehicle. According to the invention, the fuel cell module is placed in or on the motor vehicle so that the fuel cell module operates in a largely self-aspirating manner when the vehicle is moving. This means that the air of the relative wind is sufficient for supplying oxidants to the fuel cells.



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(71) Demandeurs/Applicants:
SIEMENS AKTIENGESELLSCHAFT, DE;
EMITEC GESELLSCHAFT FUR EMISSIONSTECHNOLOGIE MBH, DE

(72) Inventeurs/Inventors:
POPPINGER, MANFRED, DE;
GROSSE, JOACHIM, DE;
BRUCK, ROLF, DE;
REIZIG, MEIKE, DE

(74) Agent: FETHERSTONHAUGH & CO.

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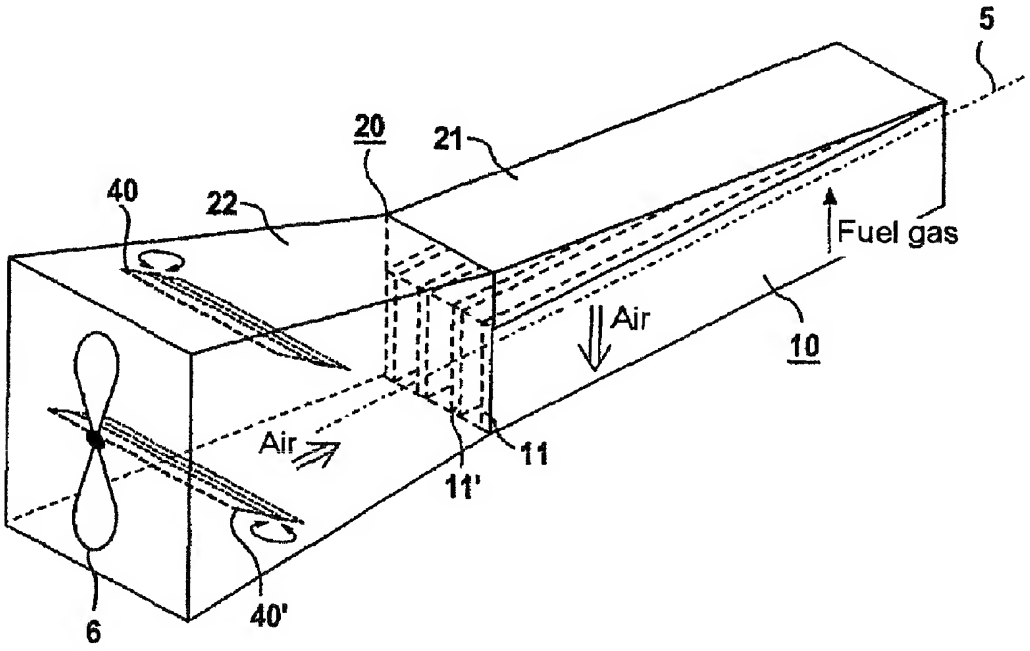

(57) Abrégé/Abstract:
An inventive fuel cell system has at least one fuel cell module that is mounted on the vehicle. According to the invention, the fuel cell module is placed in or on the motor vehicle so that the fuel cell module operates in a largely self-aspirating manner when the vehicle is moving. This means that the air of the relative wind is sufficient for supplying oxidants to the fuel cells.

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(71) Anmelder *(für alle Bestimmungsstaaten mit Ausnahme von US)*: **SIEMENS AKTIENGESELLSCHAFT** [DE/DE]; Wittelsbacherplatz 2, 80333 München (DE). **EMITEC GESELLSCHAFT FÜR EMISSIONSTECHNOLOGIE MBH** [DE/DE]; Hauptstr. 150, 53797 Lohmar (DE).

(72) Erfinder; und

(75) Erfinder/Anmelder *(nur für US)*: **POPPINGER, Manfred** [DE/DE]; Ruhsteinweg 5, 91080 Uttenreuth (DE). **GROßE, Joachim** [DE/DE]; In der Reuth 126, 91056 Erlangen (DE). **BRÜCK, Rolf** [DE/DE]; Fröbelstr. 12, 51429 Bergisch Gladbach (DE). **REIZIG, Meike** [DE/DE]; Heisterer Str. 3 A, 53579 Erpel (DE).

(74) Gemeinsamer Vertreter: **SIEMENS AKTIENGESELLSCHAFT**; Postfach 22 16 34, 80506 München (DE).

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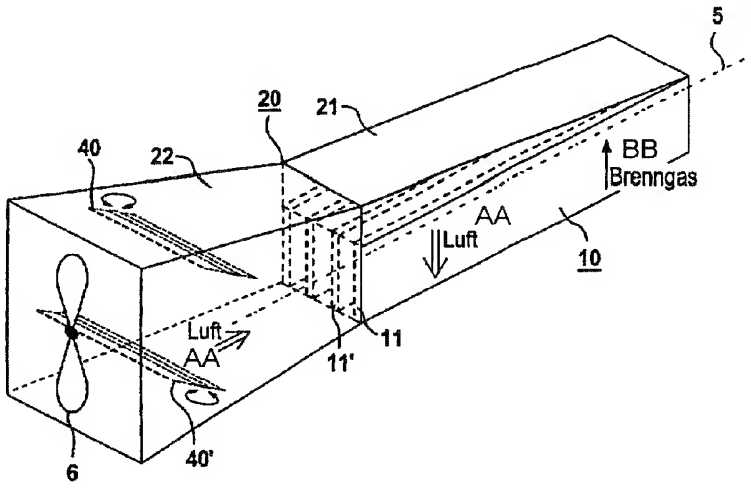
[Fortsetzung auf der nächsten Seite]

(54) **Title:** FUEL CELL SYSTEM FOR A MOTOR VEHICLE

(54) **Bezeichnung:** BRENNSTOFFZELLENANLAGE FÜR EIN KRAFTFAHRZEUG



AA AIR
BB EXHAUST GAS

(57) **Abstract:** An inventive fuel cell system has at least one fuel cell module that is mounted on the vehicle. According to the invention, the fuel cell module is placed in or on the motor vehicle so that the fuel cell module operates in a largely self-aspirating manner when the vehicle is moving. This means that the air of the relative wind is sufficient for supplying oxidants to the fuel cells.

(57) **Zusammenfassung:** Eine solche Brennstoffzellenanlage hat wenigstens ein Brenn-stoffzellenmodul, das am Fahrzeug angebracht ist. Gemäß der Erfindung ist das Brennstoffzellenmodul derart im oder am Kraftfahrzeug angeordnet, dass bei sich bewegendem Fahrzeug das Brennstoffzellenmodul weitestgehend selbstatmend arbei-tet. Dies bedeutet, dass die Luft des Fahrtwindes hinreichend zur Versorgung mit Oxidans für die Brennstoffzellen ist.

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Erklärungen gemäß Regel 4.17:

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— *Erfindererklärung (Regel 4.17 Ziffer iv) nur für US*

Veröffentlicht:

— *mit internationalem Recherchenbericht*

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Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

Description

Motor vehicle having a fuel cell system

The invention relates to a motor vehicle having a fuel cell system comprising at least one fuel cell module.

It is known to use fuel cell systems to supply energy to new drive concepts in automotive engineering. By way of example, EP 0 677 412 B1 provides a detailed description as to how the fuel cell for a drive unit in a motor vehicle should be arranged at a suitable location beneath the floor of the vehicle, since this provides optimum protection for the sensitive fuel cell module against mechanical influences. Alternative arrangements for the fuel cell system are, for example, the vehicle roof, which is suitable in particular for buses or trucks.

Furthermore, DE 196 29 084 A1 has disclosed an electric vehicle, the drive battery of which comprises a fuel cell system having a cooling system, if appropriate a secondary cooling system, through which a gaseous cooling medium flows, wherein the fuel cell system is arranged in such a way that the cooling medium - if appropriate the secondary cooling medium - is introduced into the cooling system completely or partially by the dynamic pressure of the air stream. In this case, the fuel cell system should be incorporated in the vehicle in such a way that the plane normals to the active surfaces of the individual fuel cells are perpendicular to the direction of travel. Specifically, DE 196 02 315 has disclosed a liquid-cooled fuel cell with distribution passages in which the cell surfaces are supplied with reaction media via axial supply passages and radial distribution passages. The supply

and distribution passages in the entire fuel cell stack are arranged in such a way that the cell surfaces are uniformly supplied with the operating media.

Finally, US 5,879,826 A has disclosed a PEM fuel cell arrangement having a stack of repeating units in which cooling boards with cooling circuits are arranged between the individual units.

The storage of hydrogen and refueling with hydrogen are known to present problems. PEM fuel cell systems, in particular systems with HT-PEM fuel cells, use hydrogen as fuel, which is generated from standard gasoline, from methanol or from another higher

hydrocarbon in a reformer on board the vehicle. The oxidizing agent used in this case is atmospheric oxygen, for which purpose, when the vehicle is travelling, the air from the environment, in particular from the air stream, is fed to the fuel cell. For this purpose, there must be suitable means; in the prior art, forced guides for the air are provided.

Therefore, it is an object of the invention to propose a fuel cell system for a motor vehicle which is simplified with regard to means of this type.

According to the invention, the object is achieved by the features of patent claim 1. Further developments are given in the subclaims.

By using a suitable arrangement of the fuel cell system in or on the vehicle, the invention ensures that the fuel cells operate as far as possible in a self-aspirating manner. In this context, the term "self-aspirating" is understood as meaning that there is always ample oxygen as oxidizing agent from the ambient air available in the fuel cell system, so that the fuel cell reaction can take place. There is then no need for forced guidance of the aspiration air to the cathodes of the fuel cells.

In the invention, therefore, the fuel cell module is aspirated as far as possible by the energy of the air stream. For low vehicle speeds and/or high loads in operation, there may preferably be an auxiliary blower. However, in this context it is a critical factor that there is no need for forced guides for the aspiration air, i.e. for supplying oxidizing agents to the fuel cells.

If, in a motor vehicle, the entire fuel cell system or at least individual fuel cell modules are arranged

beneath the floor of the vehicle, diverter plates and/or nozzle arrangements for introducing the

air stream are advantageously provided. Electrically actuable valves can also be used to set and control these devices.

If, in accordance with DE 196 29 084 A1, the air stream and/or the blower air are also to be used to cool the fuel cells, it is recommended for the feed air, on the one hand, and the cooling air, on the other hand, to be guided in cross-current.

In the invention, the fuel cell system -v operates with what are known as PEM fuel cells, in particular at high temperatures, i.e. the fuel cells are advantageously HT-PEM fuel cells. By suitable use of mechanical means, e.g. by diverter plates and/or nozzle arrangements, the air stream can be utilized in such a manner that it ensures optimum use of the fuel cells. In this case, the fuel cell module may be of flat design and of limited height. In particular, it also ensures that the aerodynamic properties of the motor vehicle, such as the drag coefficient or the like, are not adversely affected.

Further details and advantages of the invention will emerge from the following description of figures showing exemplary embodiments on the basis of the drawing in conjunction with the patent claims. In the drawing:

Figure 1	shows a motor vehicle with an integrated fuel cell system,
Figure 2	shows a fuel cell module for self-aspirating operation, and
Figures 3 and 4	show sectional illustrations of alternative arrangements to that shown in Figure 2.

In Figure 1, a motor vehicle is denoted by 1, and its electric motor drive 3 (not shown in detail)

is supplied by a fuel cell system. The fuel cell system substantially comprises a fuel cell module 10 and corresponding auxiliary equipment, not shown in detail in Figure 1. At least the fuel cell module 10 is positioned on or in the motor vehicle 1 in such a way that it is supplied with air in an appropriate way. Specifically, the longitudinal axis of the fuel cell module 10 runs in the direction of the vehicle longitudinal axis 5. A nozzle-like mechanical arrangement passes the air stream from a front end opening of the motor vehicle 1 to the fuel cell module 10 in such a manner that after it has been diverted the air flows in from above. In addition, a fan supplies additional ambient air when required.

Fuel cells which operate with a solid electrolyte and are referred to as PEM (polymer electrolyte membrane) fuel cells are used for the fuel cell system. Fuel cells of this type with operating temperatures of approx. 60°C are known from the prior art; for mobile applications, fuel cells of this type are advantageously operated at higher temperatures than have previously been described. Working temperatures of between 80°C and 300°C, but in particular in the range from 120 to 200°C, are used for the HT-PEM fuel cells.

A fuel cell module 10 with HT-PEM fuel cells 11, 11', ... may be of flat design. Specifically, a multiplicity of fuel cells are stacked, and consequently in this case one refers to a flat stack. A flat stack of this type is advantageously arranged beneath the vehicle floor or, if it is not a passenger automobile, may alternatively be arranged on the roof of the vehicle. This ensures that the air stream reaches the fuel cells in a suitable way with the aid of the mechanical device 20.

Figure 2 illustrates a fuel cell module 10 of this type which comprises individual HT-PEM fuel cells 11, 11',

.... The mechanical device 20, for example an obliquely running metal sheet 21 or air diverter plate, ensures that the air stream is guided and diverted in a nozzle-like arrangement and therefore reaches the individual cells 11, 11', ... of the HT-PEM fuel cell module 10 directly. For this purpose, a nozzle 22 with pivoted flaps 40 and 40' is arranged in the vehicle upstream of the fuel cell module 10, so that the air which flows in is directed in targeted fashion onto the fuel cell. There may also be electrically actuable valves with associated control devices.

The auxiliary blower 6 is used if, on account of the speed being too low, insufficient air stream is being generated or, on account of a particularly high load, there is a high demand for air. The valve arrangement, which is formed from the pivoted flaps 40 and 40' and can be electrically actuated, allows the supply of air using the air stream and/or blower air to be matched to the prevailing requirements by means of a suitable control unit (not shown).

To prevent damage to the fuel cells from cold incoming air, the aspiration air has to be preheated before it enters the fuel cells 11, 11', ... The supply of air to the fuel cell module 10 illustrated in Figure 2 can be ideally combined with the air preheating.

Figure 3 diagrammatically depicts how air is guided via the blower 5 and a heat exchanger 30 and, after it has been diverted, passes into the fuel cells 11, 11', ... of the fuel cell module 10. A corresponding arrangement in more compact form is shown in Figure 4. In both cases, a liquid medium, for example oil, as coolant is passed from the fuel cells 11, 11', ... into the heat exchanger 30. The length and height of the fuel cells 11, 11', ..., on the one hand, and of the heat

exchanger 30, on the other hand, are matched to one another,

so that the desired overall form, which is as compact as possible, is achieved.

With a fuel cell module arranged in a motor vehicle as shown in Figure 2, it is easy to operate in cross-current mode. What this means in this case is that the air which is required for operation of the fuel cells 11, 11', ... passes through the fuel cell module 10 in a vertical line, while the cooling air, after it has been diverted, in each case flows into the fuel cell module 10 in a direction which is perpendicular to the vertical. This arrangement allows the quantity of air to be set in particular in such a way that a suitable λ value can be predetermined. In practice, it has been found that a λ value of at least 2 should be maintained.

It can be seen in particular from Figure 2 that in the arrangement illustrated the air guidance has a dual function. Firstly, the oxygen in the air is used as oxidizing agent, and secondly the air is used for cooling. This enables the quantitative flow of oxidizing agent or air to be regulated as a function of the temperature of the fuel cell module 10.

It has been found that an operating temperature of between 80°C and 200°C can be maintained in particular for the use of HT-PEM fuel cells. The ideal operating temperature is in this case approx. 160°C. In this case, therefore, the air which is introduced into the fuel cell system in the motor vehicle is used not only to supply oxidizing agent but also to cool the fuel cell modules.

Patent Claims

1. A motor vehicle having a fuel cell system comprising at least one fuel cell module, having the following features:

- the fuel cell module 10 is arranged in the motor vehicle (1) in such a manner that when the vehicle (1) is moving, the fuel cell module operates as far as possible in a self-aspirating manner via an external introduction of air,
- the air for the self-aspiration of the fuel cell module is supplied as far as possible by the energy of the air stream at the motor vehicle (1),
- there is an auxiliary blower (25) to cope with low vehicle (1) speeds and/or high fuel cell module (10) loads, and
- there are diverter plates (21) and/or nozzle arrangements (22) for introducing the air stream to the fuel cell module (10).

2 The motor vehicle having a fuel cell system as claimed in claim 1, characterized in that the fuel cell module (10) includes PEM fuel cells.

3 The motor vehicle having a fuel cell system as claimed in claim 1, characterized in that the fuel cell module (10) includes HT-PEM fuel cells.

4. The motor vehicle having a fuel cell system as claimed in claim 3, characterized in that there are electrically actuable valves (40, 40') for controlling the admission of air.

5. The motor vehicle having a fuel cell system as claimed in claim 1, characterized

in that the blower (25) is used to control the quantity of air.

6. The motor vehicle having a fuel cell system as claimed in claim 1, characterized in that the fuel cell module (10) is of flat design and has a height of at most 200 mm, preferably approximately 100 mm.

7. The motor vehicle having a fuel cell system as claimed in one of the preceding claims, characterized in that the quantity of air is such that a lambda value of at least 2 is maintained.

8. The motor vehicle having a fuel cell system as claimed in one of the preceding claims, characterized in that the air is also used for cooling.

9. The motor vehicle having a fuel cell system as claimed in one of the preceding claims, characterized in that the cooling air is passed in cross-current with respect to the aspiration air.

10. The motor vehicle having a fuel cell system as claimed in one of the preceding claims, characterized in that the quantitative flow of oxidizing agent/air is controlled as a function of the temperature of the fuel cell module (10), specifically in such a way that the operating temperature is between 60°C and 300°C, preferably between 60°C and 80°C for PEM fuel cells and 120°C to 200°C for HT-PEM fuel cells.

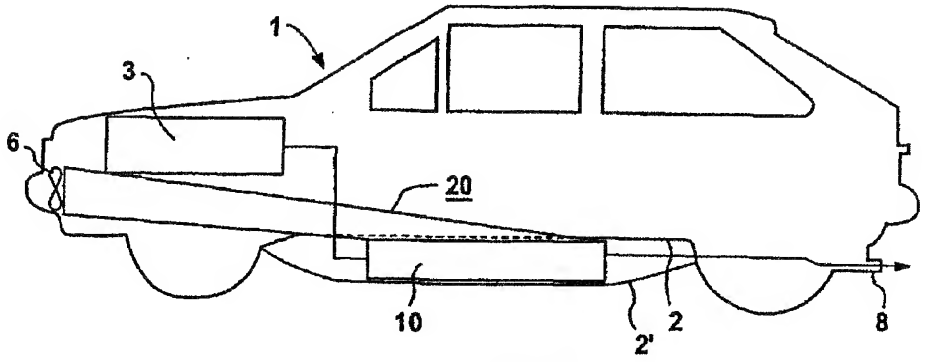

FIG 1

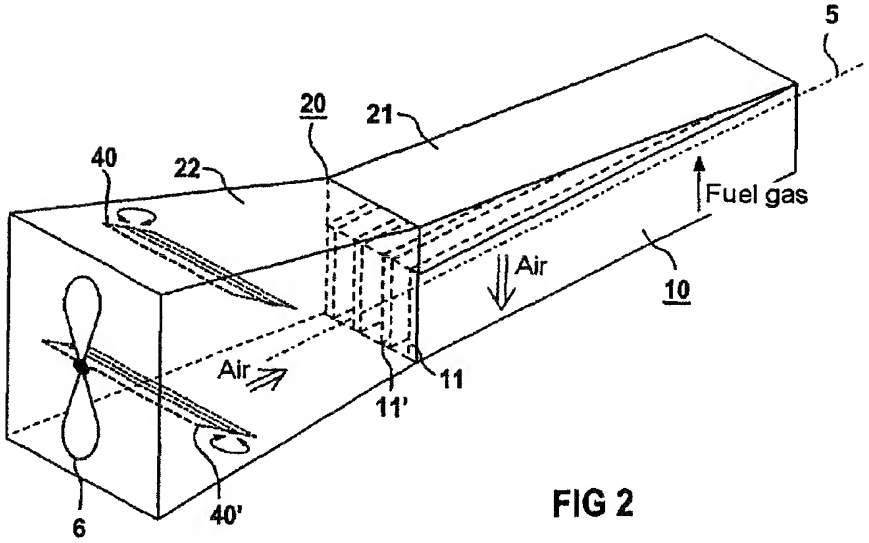

FIG 2

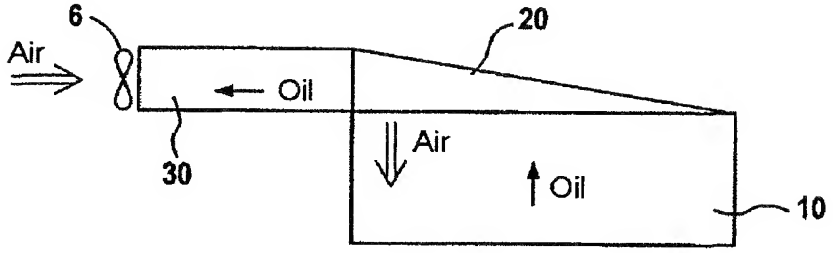

FIG 3

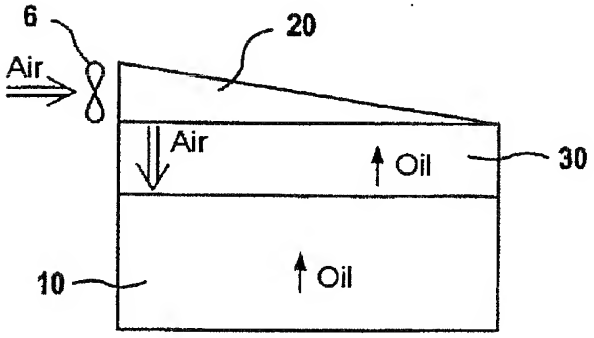

FIG 4